REMARKS

This is intended as a full and complete response to the Office Action dated July 12, 2005, having a shortened statutory period for response set extended one month to expire on November 14, 2005.

In the specification, the paragraph **[0021]** has been amended to address the Examiner's interpretation of the language of the specification. Support for the amended language of paragraph 21 can be found in paragraphs **[0078]-[0110]**

Claims 1-36 remain pending in the application and are shown above. Claims 1-8, 10-15 and 18-31 are rejected by the Examiner. Claims 9, 16-17 and 32-36 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims. Reconsideration of the rejected claims is requested for reasons presented below.

Claim Rejections – 35 U.S.C. § 102

Claims 18-21, 23, 26, and 28-29 are rejected under 35 U.S.C. § 102(e) as being anticipated by *Hongo et al* (U.S. Patent Publication No. 2004/0154931). The Examiner asserts that *Hongo et al* discloses the subject matter of claims 18-21, 23, 26, and 28-29. Applicants respectfully traverse this rejection.

Hongo et al discloses a single step copper polishing process utilizing a polishing liquid comprising hydroxyquinoline to form and remove an oxine-copper film from a substrate surface and a second polishing step for barrier removal and surface planarization. (*See,* paragraphs **[0012]-[0030]**, and paragraphs **[0089]-[0135]**). *Hongo et al* is directed to minimizing the thickness difference between raised portions and depressed portions, and thus, teaches away from the formation of a protrusion from the second overburden of conductive material deposited over wide feature definitions. (*See also,* Examples)

Additionally, the Examiner asserts that *Hongo et al* discloses a method for planarizing the substrate surface, and that *Hongo et al* does not teach a pulse technique for forming a protrusion of conductive material over a wide feature

definition. There is no suggestion or motivation in *Hongo et al* to form a protrusion over wide feature definitions.

The Examiner also asserts that a protrusion would inherently form over one of the wide feature definitions of the Electropolishing process of *Hongo et al* as a normal variation in surface roughness and the pulse technique be adapted to form such a protrusion. Applicants respectfully disagree with the Examiner's reasoning regarding inherent protrusion formation with reference to *Hongo et al*. *Hongo et al* discloses raised and depressed features and is silent as to "normal variations in surface roughness" as asserted by the Examiner that could lead to a inherent protrusion of at least microscopic or atomic proportions. *Hongo et al* is clearly directed at reducing the thickness difference between raised and depressed portions of the copper material and provides no suggestion or motivation for forming a protrusion from the second overburden of conductive material disposed over wide feature definitions. As no protrusion formation is suggested or motivated by *Hongo et al*, there is no suggestion to use a pulse technique to form a protrusion. With regard to claim 19, *Hongo et al* is silent as to a technique to form a protrusion between about 20% and about 40% of a thickness of the deposited conductive material over the wide feature definition.

Hongo et al does not teach, show, or suggest a method of processing a substrate having a substrate surface comprising a conductive material layer deposited over narrow feature definitions and wide feature definitions with the conductive layer having first overburden over the narrow feature definitions and second overburden less than the first overburden over the wide feature definitions, the method comprising polishing the substrate by an electrochemical polishing process comprising, providing the substrate to a process apparatus comprising a first electrode and a second electrode with the substrate in electrical contact with the second electrode, supplying a polishing composition between the first electrode and the substrate, wherein the polishing composition forms a passivation layer on the conductive material, abrading the passivation layer to expose a portion of the conductive material, and applying power by a pulse modulation technique between the first electrode and the second electrode to remove the conductive material

disposed over narrow feature definitions at a higher removal rate than the conductive material disposed over wide feature definitions to form a protrusion of the conductive material deposited over the wide feature definitions, and polishing the substrate by at least a chemical mechanical polishing process to remove the remaining conductive material, as recited in claim 18 and claims dependent thereon. Withdrawal of the rejection is respectfully requested.

Claim Rejections – 35 U.S.C. § 103

Claims 24-25 are rejected under 35 U.S.C. § 103(a) as being unpatentable over *Hongo et al* as applied to claim 18 above, and further in view of *Mayer et al* (U.S. Patent No. 6,315,883). The Examiner asserts that it would have been obvious to one of ordinary skill in the art at the time of applicant's invention to add the copper sulfate to the solution of *Hongo et al.* Applicants respectfully respond to the rejection.

Hongo et al is described above with regard to a hydroxyquinoline polishing composition. *Mayer et al* discloses masking regions of a wafer surface during electropolishing by forming a diffusion barrier film using concentrated phosphoric acid and certain polymers. *Mayer et al* discloses that salts of the material to be removed are added to the composition to allow immediate plating of the polished metal on the counter electrode to avoid bubble formation from hydrogen generation. There is no suggestion to in either *Mayer et al* or *Hongo et al* to combine the salt of the material to be removed in the diffusion barrier process of *Mayer et al* with the hydoxyquinoline oxine-copper layer formation composition of *Hongo et al.*

The combination of *Hongo et al* and *Mayer et al Hongo et al* does not teach, show, or suggest a method of processing a substrate having a substrate surface comprising a conductive material layer deposited over narrow feature definitions and wide feature definitions with the conductive layer having first overburden over the narrow feature definitions and second overburden less than the first overburden over the wide feature definitions, the method comprising polishing the substrate by an electrochemical polishing process comprising, providing the substrate to a process

apparatus comprising a first electrode and a second electrode with the substrate in electrical contact with the second electrode, supplying a polishing composition between the first electrode and the substrate, wherein the polishing composition forms a passivation layer on the conductive material, abrading the passivation layer to expose a portion of the conductive material, and applying power by a pulse modulation technique between the first electrode and the second electrode to remove the conductive material disposed over narrow feature definitions at a higher removal rate than the conductive material disposed over wide feature definitions to form a protrusion of the deposited conductive material over the wide feature definitions, and polishing the substrate by at least a chemical mechanical polishing process to remove the remaining conductive material, as recited in claim 18 and claims 24-25 dependent thereon. Withdrawal of the rejection is respectfully requested.

Claims 1-8, 10-11 and 13-15 are rejected under 35 U.S.C. § 103(a) as being unpatentable over *Hongo et al* in view of *Mayer et al* (U.S. Patent 6,315,883). The Examiner asserts that it would have been obvious to one of ordinary skill in the art at the time of applicant's invention to add the copper sulfate to the solution of *Hongo et al* and provide process variables by routine optimization. Applicants respectfully respond to the rejection.

Hongo et al is described above with regard to a hydroxyquinoline polishing solution to form and remove an oxine-copper film from a substrate surface. *Hongo et al* further discloses that the oxine-copper film has a relatively high electric resistance, and accordingly, flowing of electric current through the portions covered with oxine-copper is inhibited. *Mayer et al* discloses masking regions of a wafer surface during electropolishing in the absence of mechanical polishing by forming a diffusion barrier film using concentrated phosphoric acid and certain polymers. *Mayer et al* discloses that salts of the material to be removed are added to the composition to allow immediate plating of the polished metal on the counter electrode to avoid bubble formation from hydrogen generation. *Mayer et al* and *Hongo et al* teach away from one another, and there is no suggestion to in either *Mayer et al* or *Hongo et al* to combine the salt of the material to be removed in the

diffusion barrier process of *Mayer et al* with the hydoxyquinoline oxine-copper layer formation composition of *Hongo et al*.

Additionally, *Mayer et al* or *Hongo et al* does not disclose a polishing composition having one or more chelating agents having one or more amine functional groups, one or more amide functional groups, or combinations thereof, greater than about 0.2 wt.% of one or more corrosion inhibitors, one or more inorganic or organic acid salts, one or more base pH adjusting agents to provide a pH between greater than about 4.5 and about 7.

Further, neither *Mayer et al* nor *Hongo et al* disclose a protrusion formation, and thus, provide no basis for routine optimization of the respective processes, alone or in combination, to suggest or motivate the subject matter as recited in the claims.

The combination of *Hongo et al* and *Mayer et al* does not teach, show, or suggest a method of processing a substrate having a substrate surface comprising a conductive material layer deposited over narrow feature definitions and wide feature definitions with the conductive layer having first overburden over the narrow feature definitions and second overburden less than the first overburden over the wide feature definitions, the method comprising polishing the substrate by an electrochemical polishing process comprising, providing the substrate to a process apparatus comprising a first electrode and a second electrode with the substrate in electrical contact with the second electrode, supplying a polishing composition between the first electrode and the substrate, wherein the polishing composition comprises an acid based electrolyte system, one or more chelating agents having one or more amine functional groups, one or more amide functional groups, or combinations thereof, greater than about 0.2 wt.% of one or more corrosion inhibitors, one or more inorganic or organic acid salts, one or more base pH adjusting agents to provide a pH between greater than about 4.5 and about 7, and a solvent, wherein the polishing composition forms a passivation layer on the conductive material, abrading the passivation layer to expose a portion of the conductive material, applying a bias between the first electrode and the second electrode, and removing the conductive material disposed over narrow feature

definitions at a higher removal rate than the conductive material disposed over wide feature definitions to form a protrusion of the conductive material deposited over the wide feature definitions, and polishing the substrate by at least a chemical mechanical polishing process to remove the remaining conductive material, as recited in claim 1, and claims dependent thereon.

Claims 1-2, 6-7, 10-12 and 14 are rejected under 35 U.S.C. § 103(a) as being unpatentable over *Emesh et al* (U.S. Patent No. 6,736,952) in view of *Yang et al* and further in view of *Mayer et al* (U.S. Patent No. 6,315,883). The Examiner asserts that it would have been obvious to one of ordinary skill in the art at the time of applicant's invention to add the desired amount of benzotriazole to the polishing composition of *Emesh et al*, and to adjust the composition of *Emesh et al* by the pH as taught by *Yang et al,* and to combine the planarization method of *Emesh et al* with *Mayer et al.* Applicants respectfully traverse the rejection.

Emesh et al provides a process for forming a passivation layer to facilitate the planarization of a conductive material thereon. *Emesh et al* discloses that the passivation layer protects the metallized surface from electrochemical etching until contacted with contact elements. The *Emesh et al* reference lists several compounds that may be used in the composition and is silent as to an exact formulation as well as concentrations of the respective components. *Emesh et al* is silent as to protrusion formation, and thus, provide no basis for routine optimization of the respective process or composition that may be used to suggest or motivate the subject matter as recited in the claims.

Yang et al discloses a process for effecting fusion evaporation and etching on a non-conductive work piece. *Yang et al* also discloses, as indicated in FIG. 5, that etching rate is dependent upon the pH value of the conductive fluid and etching rate rises drastically as temperature increases. *Yang et al* teach away from the electrochemical mechanical polishing process of the conductive material substrate of *Emesh et al.* There is no suggestion or motivation in either *Yang et al* or *Emesh et al.* to modify the pH level of *Emesh et al.*

Mayer et al is described above. *Mayer et al* and *Emesh et al* teach away from one another, and there is no suggestion to in either *Mayer et al* or *Emesh et al* to

combine the electrochemical diffusion barrier process of *Mayer et al* with the electrical passivation process of *Emesh et al.*

Additionally *Yang et al*, *Emesh et*, or *Mayer et al*, alone or in combination, does not disclose a polishing composition having one or more chelating agents having one or more amine functional groups, one or more amide functional groups, or combinations thereof, greater than about 0.2 wt.% of one or more corrosion inhibitors, one or more inorganic or organic acid salts, one or more base pH adjusting agents to provide a pH between greater than about 4.5 and about 7.

Further, *Yang et al*, *Emesh et*, or *Mayer et al*, either alone or in combination does not disclose a protrusion formation, and thus, does not provide a basis for routine optimization of the respective processes, alone or in combination, to suggestion or motivation the subject matter as recited in the claims.

The combination of *Yang et al*, *Emesh et*, and *Mayer et al* does not teach, show, or suggest a method of processing a substrate having a substrate surface comprising a conductive material layer deposited over narrow feature definitions and wide feature definitions with the conductive layer having first overburden over the narrow feature definitions and second overburden less than the first overburden over the wide feature definitions, the method comprising polishing the substrate by an electrochemical polishing process comprising, providing the substrate to a process apparatus comprising a first electrode and a second electrode with the substrate in electrical contact with the second electrode, supplying a polishing composition between the first electrode and the substrate, wherein the polishing composition comprises an acid based electrolyte system, one or more chelating agents having one or more amine functional groups, one or more amide functional groups, or combinations thereof, greater than about 0.2 wt.% of one or more corrosion inhibitors, one or more inorganic or organic acid salts, one or more base pH adjusting agents to provide a pH between greater than about 4.5 and about 7, and a solvent, wherein the polishing composition forms a passivation layer on the conductive material, abrading the passivation layer to expose a portion of the conductive material, applying a bias between the first electrode and the second electrode, and removing the conductive material disposed over narrow feature

definitions at a higher removal rate than the conductive material disposed over wide feature definitions to form a protrusion of the conductive material deposited over the wide feature definitions, and polishing the substrate by at least a chemical mechanical polishing process to remove the remaining conductive material, as recited in claim 1, and claims dependent thereon. Withdrawal of the rejection is respectfully requested.

Claims 18-20, 25-27 and 29-30 are rejected under 35 U.S.C. § 103(a) as being unpatentable over *Emesh et al* (U.S. Patent 6,736,952 B2) in view of *Mayer et al* (U.S. Patent No. 6,315,883). The Examiner asserts that it would have been obvious to one of ordinary skill in the art at the time of applicant's invention to combine the planarization method of *Emesh et al* with the substrate of *Mayer et al.* Applicants respectfully traverse the rejection.

Emesh et al and *Mayer et al* are described above. *Mayer et al* and *Emesh et al* teach away from one another, and there is no suggestion to in either *Mayer et al* or *Emesh et al* to combine the electrochemical diffusion barrier process of *Mayer et al* with the electrical passivation process of *Emesh et al.*

Further, neither *Emesh et* nor *Mayer et al* disclose a protrusion formation, and thus, provide no basis for routine optimization of the respective processes, alone or in combination, to suggestion or motivation the subject matter as recited in the claims.

The combination of *Emesh et al* and *Mayer et al* does not teach, show, or suggest a method of processing a substrate having a substrate surface comprising a conductive material layer deposited over narrow feature definitions and wide feature definitions with the conductive layer having first overburden over the narrow feature definitions and second overburden less than the first overburden over the wide feature definitions, the method comprising polishing the substrate by an electrochemical polishing process comprising, providing the substrate to a process apparatus comprising a first electrode and a second electrode with the substrate in electrical contact with the second electrode, supplying a polishing composition between the first electrode and the substrate, wherein the polishing composition forms a passivation layer on the conductive material, abrading the passivation layer

to expose a portion of the conductive material, and applying power by a pulse modulation technique between the first electrode and the second electrode to remove the conductive material disposed over narrow feature definitions at a higher removal rate than the conductive material disposed over wide feature definitions to form a protrusion of the conductive material deposited over the wide feature definitions, and polishing the substrate by at least a chemical mechanical polishing process to remove the remaining conductive material, as recited in claim 18 and claims 18-20, 25-27 and 29, dependent thereon. Withdrawal of the rejection is respectfully requested.

The combination of *Emesh et al* and *Mayer et al* does not teach, show, or suggest a method of processing a substrate having a conductive material layer disposed thereon over narrow feature definitions and wide feature definitions, comprising removing conductive material disposed over narrow feature definitions at a higher removal rate than conductive material disposed over wide feature definitions by an electrochemical mechanical polishing technique to form a protrusion of conductive material deposited over the wide feature definitions, and removing conductive material disposed over wide feature definitions at a removal rate greater than or equal to the removal rate of conductive material disposed over narrow feature definitions by at least a chemical mechanical polishing technique, as recited in claim 30. Withdrawal of the rejection is respectfully requested.

Claim 22 is rejected under 35 U.S.C. § 103(a) as being unpatentable over *Emesh et al* in view of *Mayer et al* as applied to claim 20 above, and further in view of *Kohl et al* (U.S. Patent No. 4,369,099). The Examiner asserts that it would have been obvious to one of ordinary skill in the art at the time of applicant's invention to combine the pulse duration of *Kohl et al*, the planarization method of *Emesh et al,* and the substrate of *Mayer et al*. Applicants respectfully traverse the rejection.

Emesh et al and *Mayer et al* are described above. *Kohl et al* discloses etching p-type semiconductors using a photoelectrochemical etching process.

The combination of *Emesh et al* , *Mayer et al*, and *Kohl et al*, does not teach, show, or suggest a method of processing a substrate having a substrate surface comprising a conductive material layer deposited over narrow feature definitions and

wide feature definitions with the conductive layer having first overburden over the narrow feature definitions and second overburden less than the first overburden over the wide feature definitions, the method comprising polishing the substrate by an electrochemical polishing process comprising, providing the substrate to a process apparatus comprising a first electrode and a second electrode with the substrate in electrical contact with the second electrode, supplying a polishing composition between the first electrode and the substrate, wherein the polishing composition forms a passivation layer on the conductive material, abrading the passivation layer to expose a portion of the conductive material, and applying power by a pulse modulation technique between the first electrode and the second electrode to remove the conductive material disposed over narrow feature definitions at a higher removal rate than the conductive material disposed over wide feature definitions to form a protrusion of the conductive material deposited over the wide feature definitions, and polishing the substrate by at least a chemical mechanical polishing process to remove the remaining conductive material, wherein the pulse modulation technique comprises one or more cycles of applying a power between about 2 seconds and about 25 seconds and not applying power between about 2 seconds and about 25 seconds , as recited in claim 22. Withdrawal of the rejection is respectfully requested.

Claim 24 is rejected under 35 U.S.C. § 103(a) as being unpatentable over *Emesh et al* in view of *Mayer et al* as applied to claim 18 above, and further in view of *Yang et al* (U.S. Patent No. 6,596,152).

The Examiner asserts that it would have been obvious to one of ordinary skill in the art at the time of applicant's invention to combine the pulse duration of *Kohl et al*, the planarization method of *Emesh et al,* and the substrate of *Mayer et al.* Applicants respectfully traverse the rejection.

Yang et al, *Emesh et*, and *Mayer et al* are described above with regard to the polishing composition of claim 1. The combination of *Yang et al*, *Emesh et*, and *Mayer et al* does not teach, show, or suggest a method of processing a substrate having a substrate surface comprising a conductive material layer deposited over narrow feature definitions and wide feature definitions with the conductive layer

having first overburden over the narrow feature definitions and second overburden less than the first overburden over the wide feature definitions, the method comprising polishing the substrate by an electrochemical polishing process comprising, providing the substrate to a process apparatus comprising a first electrode and a second electrode with the substrate in electrical contact with the second electrode, supplying a polishing composition between the first electrode and the substrate, wherein the polishing composition forms a passivation layer on the conductive material, abrading the passivation layer to expose a portion of the conductive material, and applying power by a pulse modulation technique between the first electrode and the second electrode to remove the conductive material disposed over narrow feature definitions at a higher removal rate than the conductive material disposed over wide feature definitions to form a protrusion of the conductive material deposited over the wide feature definitions, and polishing the substrate by at least a chemical mechanical polishing process to remove the remaining conductive material, an acid based electrolyte system, wherein the composition comprises one or more chelating agents having one or more amine functional groups, one or more amide functional groups, or combinations thereof, greater than about 0.2 wt.% of one or more corrosion inhibitors, one or more inorganic or organic acid salts, one or more base pH adjusting agents to provide a pH between greater than about 4.5 and about 7, and a solvent, wherein the polishing composition forms a passivation layer on exposed conductive material, as recited in claim 24. Withdrawal of the rejection is respectfully requested.

Claims 30-31 are rejected under 35 U.S.C. § 103(a) as being unpatentable over *Wang et al* (U.S. Patent No. 6,447,668) in view of *Mayer et al* (U.S. Patent No. 6,315,883 B1) and in view of the admission of the background section of parent application (U.S. Patent 6,811,680 B2). The Examiner asserts that it would have been obvious to one of ordinary skill in the art to combine the planarizing method of *Wang et al* with the substrate of *Mayer et al.* Applicants respectfully respond to this rejection.

Mayer et al is described above with reference to an electropolishing process. *Wang et al* discloses an electropolishing process for a metal layer formed on the

substrate surface with the power application capable of pulse technique. Both *Mayer et al* and *Wang et al* are silent to a electrochemical mechanical polishing technique and at least a chemical mechanical polishing technique. Both *Mayer et al* and *Wang et al* are silent to forming a protrusion over wide feature definitions.

The combination of *Emesh et al* and *Mayer et al* does not teach, show, or suggest a method of processing a substrate having a conductive material layer disposed thereon over narrow feature definitions and wide feature definitions, comprising removing conductive material disposed over narrow feature definitions at a higher removal rate than conductive material disposed over wide feature definitions by an electrochemical mechanical polishing technique to form a protrusion of conductive material deposited over the wide feature definitions, and removing conductive material disposed over wide feature definitions at a removal rate greater than or equal to the removal rate of conductive material disposed over narrow feature definitions by at least a chemical mechanical polishing technique, as recited in claim 30, and claims dependent thereon. Withdrawal of the rejection is respectfully requested.

In conclusion, the references cited by the Examiner, alone or in combination, do not teach, show, or suggest the invention as claimed.

The secondary references made of record are noted. However, it is believed that the secondary references are no more pertinent to the Applicant's disclosure than the primary references cited in the office action. Therefore, Applicant believes that a detailed discussion of the secondary references is not necessary for a full and complete response to this office action.

Having addressed all issues set out in the office action, Applicant respectfully submits that the claims are in condition for allowance and respectfully request that the claims be allowed.

Respectfully submitted,

Brian K. Hrna
Registration No. 41,852
MOSER, PATTERSON & SHERIDAN, L.L.P.
3040 Post Oak Blvd. Suite 1500
Houston, TX 77056
Telephone: (713) 623-4844
Facsimile: (713) 623-4846
Attorney for Applicant(s)